09/857106
27 AUG 2001

Parallel hybrid motorization torque control system

This patent relates to a parallel hybrid motorization torque control system for motor vehicles.

motors

More specifically it pertains to a torque control system for heat or electric engines that make up the parallel hybrid motorization, in particular for an alternator starter.

A few definitions are provided hereafter. Parallel hybrids are motor-driven engine groups in which a heat engine, an electric engine powered by a storage battery and a mechanical transmission are coupled using a device that makes it possible to link them to each other in rotation. Where the electric engine is likely to function as either a motor or as a current generator. This type of motorization has the advantage of being able to use both types of power, thermal and electric, alternatively or simultaneously. The switch from one operational configuration to the other is carried out by means of control that handle all control and power management functions.

The alternator-starter is a specific parallel hybrid that consists of an electronically managed electric engine, placed between the engine and the gearbox and that replaces the starter, the alternator and the traditional engine flywheel. This type of hybrid also consists of two batteries, a utility battery used to power the electrical network in particular during the taxiing phase and a power battery used mainly to supply energy to the electric engine.

It turns out that in such a motor-driven engine group, many parameters can influence the electric and heat engines' torque requirements. These various parameters change with the advances in technology or the regulatory limitations in such a way that it is necessary to completely review the torque control system when such changes take place.

09857106.072701

The object of the invention is to remedy this situation and in particular to propose a torque control system for a vehicle equipped with a parallel hybrid motor-driven engine group of the above-mentioned type and whose architecture has potential for change.

With this end in view, the object of the invention is a parallel hybrid motor-driven engine group torque control system for a motor vehicle, where the hybrid motor-driven engine group consists of an electric engine and a heat engine linked together in rotation to a mechanical chain adapted so as to allow the two engines to provide, either alternatively or simultaneously, engine power to the wheels of the vehicle, characterized by the fact that it consists of:

- means that can determine the state of the vehicle;

- means that can manage the methods of operation of the hybrid motor-driven engine group adapted to receive, at the input, a portion of the Boolean or non-Boolean data from the means that determine the state of the vehicle;

- means that can help the dynamic performance of the vehicle, adapted to receive, at the input, the other portion of the Boolean or non-Boolean data from the means that determine the state of the vehicle;

- means that manage the electric power available for the vehicle;

- means that determine the state of the motor-driven engine group;

- means that constantly determine the total engine torque (Cm) to be provided to the vehicle's wheels, adapted to receive, at the input, the Boolean or non Boolean data from the means that manage and assist and the data from the means that determine the state of the motor-driven engine group, by giving priority to the data obtained from the means that manage and assist, in order to respectively control the torque (Ce) of the

electric engine and the torque (Ct) of the heat engine based on the desired (Ce) / (Ct) ratio.

In the context of the invention "Engine power" means the product of the engine torque and the engine speed that is provided either alternatively or simultaneously by the heat and the electric engine.

Similarly, by "means that determine the state of the vehicle", we mean the means that make it possible to analyze the Boolean or non Boolean data provided by the sensors located on the vehicle. For example, the information provided will be the speed of the vehicle, the speed of the heat engine, the gear ratio …

By "means that assist the dynamic performance", we mean calculation means that make it possible to improve the use of the engine brake (motor-driven engine group), to improve the heat engine's anti-stalling and the dynamic compensation torque when climbing.

By "means that manage the methods of operation of the motor-driven engine group", we mean the means that make it possible to start or not start the heat and/or electric engine and to fine tune the torque (Cm) that is to be transmitted to the vehicle's wheels when restarting the vehicle in circulation, usually called "stop and start".

Advantageously, the system as set forth in the invention consists of a man /engine interface adapted in such a way that it can receive, at the input, the Boolean data provided by the means that determine the state of the motor-driven engine group and can provide, at the output, certain visual data to the driver in order to allow him/her to chose a method of operation of the motor-driven engine group.

According to one attractive characteristic of the invention, the system consists of means that can cool the motor-driven engine group, such as a fan, adapted to receive, at

the input, at least a portion of the Boolean or non Boolean data provided by the means that determine the state of the motor-driven engine group.

Preferably, the electric engine is comprised of an alternator and of a starter.

The main advantage of such a system is its upgradeable architecture. Indeed, it is easily possible to modify any means as they are set forth in the invention independently from each other if the electric engine of the motor-driven engine group or at least one battery changes, if the heat engine of the motor-driven engine group and/or the desired hybridization rate (Cth/Ce) changes or if the driver's desired conditions change in order to restart a stationary motor-driven engine group.

Advantageously, such a system also makes it possible to use a modular architecture. Indeed, it is possible to place it on a vehicle equipped with a motor-driven engine group that is only equipped with a heat engine.

Lastly, it makes it possible to conserve a lot of energy as it makes possible an undersizing of the heat engine and/or an extension of the axle ratios called "downsizing" while maintaining, if not improving, the dynamic performance of a high power engine or a traditional chain.

The above-mentioned characteristics of the invention, as well as other characteristics, will become clearer after having read the following description and analyzed the attached drawing in which the only figure represents a block diagram that illustrates an example of execution of a torque control system for an alternator-starter as set forth in this invention.

In this only figure, we recognize an electric engine 1 and a heat engine 3, both connected in rotation to a mechanical chain 3 that allows both engines to selectively provide the engine power to the wheels 4 of the vehicle.

Each of the two engines, electric 1 and heat 2, are respectively connected to a torque control system 5, as set forth in this invention, in order to regulate the torque of each one of them based on the life situations of the motor vehicle.

Advantageously, the torque control system of the electric 1 and heat 2 engines as set forth in the invention, is mainly comprised of a torque management unit 6 linked to the starting and stopping of the engine or the heat engine 2, a management unit for the autonomy of the electrical energy 7, a unit that determines the life situation of the vehicle 8, a unit that determines the life situation of the overall device comprised of the alternator-starter system and its central or monitoring control 9, and a unit that determines the torque 10 that receives, at the input, information provided by the various other units in order to respectively control the torque Ce of the electric engine 1 and the torque Ct of the heat engine 2.

Furthermore, the system 5 can also consist of a man/engine interface 11 that is connected to the vehicle's central monitor, not represented, in order to warn the driver and the vehicle's other systems of the state of the alternator-starter system, and allow the driver to chose the method of operation of the alternator-starter system, a torque management unit 12 connected to the dynamic performance assistance, and a cooling management unit 13 that receives, at the input, the temperature T data of the electric engine and the water data of the heat engine.

We will successively describe the function of each of the units that make up the torque control system as set forth in the invention.

The torque management unit 6, connected to the starting and stopping of the engine, analyzes the heat engine control state information in order to establish the state of the motor-driven engine group on the one hand, the final conditions of an authorization to perform a stop or request a start up on the other hand, from information transmitted in particular through the unit that determines the life situation of the vehicle 8. This unit coordinates the calculation of the torque instructions to be performed by the electric

engine 1 and the orders to the heat engine control 2 to start or stop the engine. The electrical torque to be applied to the shaft to start or stop the heat engine is calculated by controlling the speed on the slow down instruction. This unit also determines the heat conditions, namely cold start, for the engine that contributes to the evaluation of the necessary electrical power. The management unit for the range of the electrical power 7 that calculates the available electrical power implements the coherent actions, among others the piloting of converters or the choice of start up by the traditional starter, so as to deliver the necessary energy during start up.

This energy management unit 7 is designed to mainly transmit six pieces of information to the torque determination unit 10 that drives the electric engine 1 and the heat engine 2, respectively: evaluation, the desirable generation torque to maximize the vehicle's electric power, the maximum power feasible in traction, the evaluation of the maximum allowable generation power, the authorization to make a stop or to request a start of the heat engine, and the state and type of the charge, based on the information generated for the most part by the power battery that supplies the electric engine and where appropriate, as supplementary power, utility batteries that supply the low voltage system of distribution.

The unit that determines the life situation of the vehicle 8 synthesizes the information generated by the vehicles sensors on the one hand (driver presence sensor, neutral sensor...) and by the dialog with other devices on the other hand, including the driver's wishes by synthesizing in particular the position of the clutch, the accelerator, the vehicle's speed and the gear ratio in order to determine the authorization for a possible cut-off of the heat engine toward the management function of the motor-driven engine group 6, or the identification of an activation of compensation of the heat engine transients toward the dynamic performance torque management function, such as assistance when maneuvering.

All this information, torque instructions, generated or in the engine, obtained from the torque allocation or request management units 6, 7 and 12 for a device or an identified

function as defined above and the states or alerts of these same functions are transmitted to the unit that determines the torque 10. On the other hand, the unit that determines the life situation of the alternator-starter system 9 transmits the information pertaining to its life situation to the unit that determines the torque 10 making it possible to establish the final torque instruction distributed between the heat engine on the one hand and the electric engine of the other hand, allocating, based on the life case, the priority to the management functions of the motor-driven engine group 6, the electric autonomy 7 or the dynamic performance 12.

A man/engine interface can advantageously be included in the system as set forth in the invention in order to constantly inform the driver and the other vehicle's devices of the life situations of the alternator-starter system and to acquire the driver's choices of operation.

Similarly, in an advantageous manner, a torque management unit 12, connected to the dynamic performance assistance, can be included in the system in order to calculate the heat engine transient compensation torque instructions, the regenerative and anti-stalling braking, using in particular the information generated by the unit that determines the life situation of the vehicle 8, as well as the torque and the speed performed by the heat engine. Based on this variable, the electric torque to be applied in order to avoid stalling the engine is generated by a servo calculation of the engine speed when idling. As for the torque to be applied, in particular in the case of a down-sizing heat engine, it is calculated using the sum of the torques of the two engines, heat and electric, and the driver torque instruction.

Advantageously, a cooling unit 13 guarantees the start-up of a fan based on heat engine temperature and utility and power battery criteria.

We can thus foresee that such a system would be upgradeable since a torque request function (pull or generation) can easily be added. Similarly, any unit can be modified, with fixed interfaces, independently from the other units in case of a change in the

electric engine, the heat engine and possibly the vehicle's stop orders or requests for start-up.

Furthermore, the arrangement of the above-described system makes it possible to make adjustments regardless of the number of power batteries.

It of course goes without saying that various methods of operation of such a system are possible.